

What is claimed is:

1. A vial adapter for interconnecting with vial closures of different diameters, each closure having a seal, comprising:

an adapter housing having a first end with an inner periphery with a circular array of claws, and having a second end, the housing having a thickness at the
5 inner periphery; and

a sharpened cannula extending from the first end of the adapter housing for penetrating a seal of a vial closure to establish fluid communication between the vial and the first end;

wherein the array of claws comprises:

10 a first set of claws extending radially inwardly from the inner periphery, each of which has a first length; and

a second set of claws extending radially inwardly from the inner periphery, each of the second set of claws having a second length that is longer than the first length of the first set of claws, each of the second set of
15 claws adapted such that when the vial adapter is placed over a closure exceeding a selected diameter, each of the second set of claws will deflect and plastically deform thereby permitting the second set of claws to accommodate the larger closure.

2. The vial adapter of claim 1 wherein the length of each of the first set of claws is selected to engage a larger diameter vial closure.

3. The vial adapter of claim 1 wherein the length of each of the second set of claws is selected to engage a smaller diameter vial closure.

4. The vial adapter of claim 1 wherein the second set of claws are thinner than the adapter housing at the inner periphery and plastic deformation of the second set of claws occurs at a location along the length of the thinner second claws.

5. The vial adapter of claim 4 wherein the thickness of the second set of claws is selected so that when plastically deformed, the second set of claws do not apply a substantial force to the closure which may tend to decouple the vial adapter from the closure.

6. The vial adapter of claim 1 wherein the second set of claws comprises a narrowed segment at which the plastic deformation takes place.

7. The vial adapter of claim 1 wherein the length of each of the second set of claws is selected such that when the adapter engages a smaller diameter vial closure, each of the second set of claws deforms elastically to engage the smaller vial closure.

8. The vial adapter of claim 7 wherein the second set of claws deflect elastically as a result of a force directed axially through the center line of the vial adapter so that the second set of claws will snap under a crimped retaining cap surrounding a rubber stopper placed in the opening of the vial.

9. The vial adapter of claim 1 wherein the second set of claws are located at the inner periphery so that they are alternating with the first set of claws about the inner periphery.

10. The vial adapter of claim 1 wherein the adapter housing further comprises a shroud forming a part of the adapter housing at the first end, the shroud extending from the first end far enough to surround the sharpened portion of the sharpened cannula to protect an operator of the vial adapter from
5 inadvertent puncture by the sharpened cannula.

11. The vial adapter of claim 1 wherein the cannula comprises a protruding rib located so that when the cannula is engaged with the rubber stopper of a vial closure, the protruding rib resists rotation of the cannula once the

sharpened cannula with the protruding rib have punctured the rubber stopper of
5 the closure.

12. The vial adapter of claim 11 wherein the protruding rib is elongated and oriented parallel to a longitudinal axis of the central cannula.

13. The vial adapter of claim 11 wherein the cannula comprises a plurality of protruding ribs elongated and oriented parallel to a longitudinal axis of the central cannula.

14. The vial adapter of claim 1 wherein each of the first set of claws has a terminal end and each of the second set of claws has terminal end and the terminal ends of the first set of claws and the terminal ends of the second set of claws are located in a common plane.

15. The vial adapter of claim 1 further comprising a resealable needle-free valve located in the second end of the adapter housing, wherein the needle-free valve opens to permit fluid flow upon insertion of a blunt cannula and closes to prevent fluid flow upon removal of such blunt cannula.

16. The vial adapter of claim 15 wherein the resealable needle-free valve comprises a valve housing within which is disposed a deformable piston element that provides a fluid flow path through its interior, the piston element having a naturally open bore wherein the bore is closed to prevent fluid flow when the
5 needle-free valve is not accessed and wherein the bore opens to its naturally open shape to permit fluid flow when the valve is accessed.

17. The vial adapter of claim 16 wherein:
the housing of the resealable needle-free valve comprises a connection port, an exit orifice, a first section of a first cross-sectional size disposed adjacent the

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connection port, and a second section of a second cross-sectional size that is larger
5 than the first section; and

the piston element comprises a deformable piston head in which the bore is formed, the piston head being movable from the first section of the valve housing as the needle-free valve is accessed and movable to the second section of the valve housing when the needle-free valve is not accessed, the first section having a size
10 that deforms the piston head so as to occlude the bore, the second section having a size that allows the piston head to assume its natural shape in which the bore is open to provide a fluid flow path between the connection port and the exit orifice.

18. The vial adapter of claim 16 wherein:

the housing of the resealable needle-free valve comprises a connection port and an exit orifice; and

when the needle-free valve is accessed, the interior of the deformable piston
5 element provides the fluid flow path through the needle-free valve between the connection port and the exit orifice.

19. A vial adapter for interconnecting with drug vial closures of different diameters, each closure having a seal, the vial adapter comprising:

an adapter housing having a first end with an inner periphery and a circular array of claws extending radially inward from the periphery, and a second end, the
5 adapter housing having a thickness at the inner periphery;

the first end including a base, a central cannula extending from the base; a sharpened cannula located at the first end to perforate a vial's rubber stopper and provide fluid communication between the vial and the first end;

wherein the circular array of claws comprises a first set of claws, each of
10 which has a first length;

wherein the circular array of claws comprises a second set of claws, each of which has a second length that is longer than the first length of the first set of claws, each of the second set of claws adapted to deflect and plastically deform



when the adapter is placed over a closure exceeding a selected diameter, thereby
15 permitting the second set of claws to accommodate the larger closure size; and
a resealable needle-free valve located at the second end of the body that
opens to permit fluid flow upon insertion of a blunt cannula and closes to prevent
fluid flow upon removal of such blunt cannula.

20. The vial adapter of claim 19 wherein the length of each of the first
set of claws is selected to engage a larger diameter vial closure.

21. The vial adapter of claim 19 wherein the length of each of the second
set of claws is selected to engage a smaller diameter vial closure.

22. The vial adapter of claim 19 wherein the second set of claws are
thinner than the inner periphery and plastic deformation of the second set of claws
occurs at a location along the length of the thinner second claws.

23. The vial adapter of claim 19 wherein each of the second set of claws
comprises a narrowed segment at which the plastic deformation takes place.

24. The vial adapter of claim 19 wherein the length of each of the second
set of claws is selected such that when the adapter engages a smaller diameter vial
closure, each of the second set of claws deforms elastically to engage the smaller
vial closure.

25. The vial adapter of claim 24 wherein the second set of claws deflect
elastically as a result of a force directed axially through the center line of the vial
adapter and the claws snap under the vial cap.

26. The vial adapter of claim 19 wherein each of the second set of claws
is located at the periphery such that they are alternating with the first set of claws.

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27. The vial adapter of claim 19 wherein the adapter housing further comprises a shroud forming a part of the housing at the first end, the shroud extending from the first end far enough to surround the sharpened portion of the sharpened cannula to protect an operator of the vial adapter from inadvertent
5 puncture by the sharpened cannula.

28. The vial adapter of claim 19 wherein the cannula comprises a protruding rib located so that when the cannula is engaged with the rubber stopper of a vial closure, the protruding rib resists rotation of the cannula once the sharpened cannula with the protruding rib have punctured the rubber stopper of
5 the closure.

29. The vial adapter of claim 28 wherein the protruding rib is elongated and oriented parallel to a longitudinal axis of the central cannula.

30. The vial adapter of claim 28 wherein the cannula comprises a plurality of protruding ribs elongated and oriented parallel to a longitudinal axis of the central cannula.

31. The vial adapter of claim 19 further comprising a resealable needle-free valve located in the second end of the adapter housing, wherein the needle-free valve opens to permit fluid flow upon insertion of a blunt cannula and closes to prevent fluid flow upon removal of such blunt cannula.

32. The vial adapter of claim 31 wherein the resealable needle-free valve comprises a valve housing within which is disposed a deformable piston element that provides a fluid flow path through its interior, the piston element having a naturally open bore wherein the bore is closed to prevent fluid flow when the
5 needle-free valve is not accessed and wherein the bore opens to its naturally open shape to permit fluid flow when the valve is accessed.

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33. The vial adapter of claim 32 wherein:

the housing of the resealable needle-free valve comprises a connection port, an exit orifice, a first section of a first cross-sectional size disposed adjacent the connection port, and a second section of a second cross-sectional size that is larger
5 than the first section; and

the piston element comprises a deformable piston head in which the bore is formed, the piston head being movable from the first section of the valve housing as the needle-free valve is accessed and movable to the second section of the valve housing when the needle-free valve is not accessed, the first section having a size
10 that deforms the piston head so as to occlude the bore, the second section having a size that allows the piston head to assume its natural shape in which the bore is open to provide a fluid flow path between the connection port and the exit orifice.

34. The vial adapter of claim 32 wherein:

the housing of the resealable needle-free valve comprises a connection port and an exit orifice; and

when the needle-free valve is accessed, the interior of the deformable piston
5 element provides the fluid flow path through the needle-free valve between the connection port and the exit orifice.

35. A vial adapter for interconnecting with drug vial closures of different diameters, each closure having a seal, the vial adapter comprising:

an adapter housing having a first end with an inner periphery and a circular array of claws extending radially inward from the inner periphery, and having a
5 second end, the adapter housing having a thickness at the inner periphery;

the first end including a base with a sharpened central cannula extending from the base;

wherein the circular array of claws comprises a first set of claws each of which has a first length and a second set of claws each of which has a second
10 length that is longer than the first length;

wherein each claw of the second set of claws is thinner than the inner periphery and plastic deformation of the second set of claws occurs at a location at which the second set of claws are joined to the inner periphery such that when the adapter is placed over a closure exceeding a selected diameter, each of the second set of claws deflects upon contact with the closure and plastically deforms
15 permitting the claws to deflect sufficiently to accommodate the larger closure; and
a needle-free valve comprising a valve housing within which is disposed a deformable piston element that provides a fluid flow path through its interior, the piston element having a naturally open bore wherein the bore is closed to prevent
20 fluid flow when the needle-free valve is not accessed and wherein the bore opens to its naturally open shape to permit fluid flow when the valve is accessed.

36. The vial adapter of claim 35 wherein the second set of claws alternate with the first set of claws about the inner periphery such that each of the claws of the second set of claws is located between two claws of the first set.

37. The vial adapter of claim 36 wherein the adapter housing further comprises a shroud forming a part of the adapter housing at the first end, the shroud extending from the first end far enough to surround the sharpened portion of the sharpened cannula to protect an operator of the vial adapter from
5 inadvertent puncture by the sharpened cannula, wherein the circular array of claws extends from the shroud.

38. The vial adapter of claim 37 wherein:
the housing of the resealable needle-free valve comprises a connection port and an exit orifice; and
when the needle-free valve is accessed, the interior of the deformable piston
5 element provides the fluid flow path through the needle-free valve between the connection port and the exit orifice.

39. The vial adapter of claim 38 wherein the cannula comprises a protruding rib located so that when the cannula is engaged with the rubber stopper of a vial closure, the protruding rib resists rotation of the cannula once the sharpened cannula with the protruding rib have punctured the rubber stopper of
5 the closure.

40. The vial adapter of claim 39 wherein the protruding rib is elongated and oriented parallel to a longitudinal axis of the central cannula.

41. The vial adapter of claim 40 wherein the cannula comprises a plurality of protruding ribs elongated and oriented parallel to a longitudinal axis of the central cannula.

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